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Attorney Docket No.: TH-1354 (US)
A Named Inventor/Application Identifier: DAVID R. SMITH
Express Mail Label No.: EL 281130240 US
Title: METHOD TO MONITOR INTERNAL PARAMETERS OF ELECTRICAL MOTOR SYSTEMS
Date: March 23, 2000

UTILITY PATENT APPLICATION TRANSMITTAL
UNDER 37 CFR 1.53(b)

Assistant Commissioner for Patents
Box Patent Applications
Washington, DC 20231

1. ☒ This application is a(n):

   a. ☒ Original
   b. ☐ Continuation-in-part of Application Serial No. _____ filed _____
   c. ☐ Divisional of Application Serial No. _____ filed _____
      ☐ Applicant(s) elect the invention of Group/Species _____
   d. ☐ Continuation of Application Serial No. _____ filed _____

2. ☒ Specification

   a. ☒ Pages 8
   b. ☒ Drawings, Total sheets: 2

3. ☐ Oath or Declaration

   a. ☐ Newly executed (original or copy)
   b. ☐ Copy from a prior application
      ☐ Please delete the following named inventors in the prior application: _____

4. ☒ Please amend the specification

   a. ☐ By inserting before the first line:
      This is a ☐ continuation ☐ division ☐ continuation-in-part of Application Serial No. _____ filed _____, the entire disclosure of which is hereby incorporated by reference
   b. ☒ By inserting before the first line:
      This application claims the benefit of U.S. Provisional Application No. 60/125,857 filed March 24, 1999, the entire disclosure of which is hereby incorporated by reference
   c. ☐ Cancel claims _____

5. ☐ This application claims the benefit of Application Number _____ filed on _____ in _____ under 35 U.S.C. § 119, § 365(a), or § 365(b). (For originals)

6. ☐ Microfiche Computer Program (Appendix)

7. ☐ Recognize as an associate attorney _____, Registration No. _____

8. ☒ Address all future communications to:

Beverlee G. Steinberg
Shell Oil Company
Legal – Intellectual Property
P. O. Box 2463
Houston, Texas 77252-2463

9. ☒ Fee Transmittal (duplicate enclosed)

(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
TOTAL CLAIMS (37 CFR 1.16(c))	9 - 20 =	0	X $18.00 =	$ 0
INDEPENDENT CLAIMS (37 CFR 1.16(b))	3 - 3 =	78.00	X $78.00 =	0
MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			+ $260.00 =	
			BASIC FEE (37 CFR 1.16(a))	$690.00
		Total of above Calculations =		0
			TOTAL =	$ 690.00

10. ☒ Please charge Deposit Account No. 19-1800 in the amount of $690.00.

11. ☒ The Assistant Commissioner is authorized to charge all additional required fees or to credit overpayments, to Deposit Account No. 19-1800, including fees required under 37 CFR 1.17

12. ☒ Accompanying Application Parts

a. ☐ Recordal of Assignment and Assignment
b. ☐ Information Disclosure Statement/PTO-1449
c. ☐ Preliminary Amendment
d. ☒ A self-addressed, stamped return receipt postcard to be returned with the filing date and Serial No. thereon
e. ☐ Certified copy of priority documents

Respectfully submitted,

DAVID R. SMITH

By _____
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Houston, Texas 77252-2463

METHOD TO MONITOR INTERNAL PARAMETERS OF ELECTRICAL MOTOR SYSTEMS

Field of the Invention

This invention relates to an improved process to measure and monitor conditions of electrical motor systems, particularly submersible motor systems, using a deployment of optic fibers, sensors, and micomachines wound integrally with the electrical wire used in the construction of an electrical motor's stator or armature.

Background of the Invention

It is often useful from both a design and development prospective as well for operational control, safety, and extending motor life, to monitor certain internal parameters of an electric motor. Electrical motor performance and life cycle are functions of internal conditions. However, monitoring the internal parameters of electrical motors has not, in the past, been commonly done and is particularly difficult on motors which function in fairly inaccessible locations, such as those used subsurface or subsea during oil and gas operations.

Summary of the Invention

The present invention solves the problem of monitoring internal electrical motor parameters. To this end there is provided a process for measuring and monitoring motor systems, said process comprising:

providing a motor system having at least one component selected from a stator and an armature, said at least one component connected to at least one electrical wire;

incorporating at least one means for data measurement with said at least one electrical wire;

collecting data with said at least one means for data measurement; and

transferring said collected data to a data collection station.

Brief Description of the Drawings

Fig. 1 is a schematic cross-sectional view of an electrical motor having a stator with electrical wires of which at least one wire is equipped with a fiber optical sensor system embedded in the insulation.

Fig. 2 shows a cross-sectional view of the wire with fiber optical sensor system of Fig. 1.

Fig. 3 shows a longitudinal sectional view of the wire and fiber optical sensor system of Fig. 1.

Detailed Description

It is often useful from both a design and development prospective as well for operational control, safety, and extending motor life, to monitor certain internal parameters of an electric motor. The process of the invention allows parameters to be measured along multiple nodes along the axis of the motor as well as at different radial positions in the motor. These variables give useful insight to heat rise, heat flux, hot spots, and the subsequent heat profiles in different motor designs, as well as offering an intimate knowledge of the motors internal conditions of pressure and vibration, and stator movement under during actual running and operation of the electrical system.

Monitoring of the internal conditions of an electrical motor allows electrical motor performance and life cycle to be increased. Further, the monitoring process allows for improvements and or changes in design and operations to be made and then confirmed via the internal monitoring offered by this invention.

The most direct application of this technology is in the development of electrical motors, particularly for subterranean oil and gas wells, which exhibit higher reliability, greater efficiency. Many internal parameters may be measured. For example, it is often very useful to monitor the internal vibration of an electrical motor in operations to

detect poor dampening in the system, poor alignment of the motor rotor, or vibrations induced by start ups or implements and devices attached to the motors (e.g., compressors, fans, pumps, etc). Electronic communications, whether optical or otherwise, may also be passed through an electrical motor from outside the electrical motor.

The process of the invention comprises providing a motor system having at least one component selected from a stator and an armature, and at least one means for data measurement. Means for measuring data useful in the process of the invention include optic fibers, sensors, micomachines, and combinations thereof. Data is collected from the data measurement means and transferred to a data collection station. When optic fibers are used, the fibers become both the means for measuring data and a means for transferring the data to the collection station. If the motor is subsurface or subsea, the data collection station could be at the surface or above the surface of the sea.

The at least one means for data measurement needs to be associated with the at least one motor component. In one embodiment the at least one motor component is connected to at least one electrical wire to which the data measurement means is connected or incorporated. In a preferred embodiment, the at least one means for data measurement is incorporated with the at least one electrical wire. This may be accomplished, for example, by wrapping optic fiber and sensors familiar to those in the art of telemetry around the electrical wire and then encapsulating and attaching the optic fiber to the wire by covering or coating the electrical wire and the optic fiber with an insulation material. For example, an optic fiber and sensors, machines, and devices may be wound longitudinally along the length of the electric wire. The two may then be wound through the electric motor stator slots to form the stator windings of the motor. The stator may then have

insulation applied to it and the electric wires through varnishing, epoxy coating, or any of the other insulation techniques used by those familiar to the art of making motors. The curing temperature of the insulation materials may also be closely monitored by using the data measurement means as an intrinsic temperature monitor. For example, if the data measurement means is an optic fiber, optical time domain reflectometry techniques and Raman backscattering may be used.

In another embodiment of the invention, the optic fiber and the associated devices for monitoring may be placed in a tube which is wound in the stator of the electrical motor with the electrical wire.

Another embodiment uses optic fiber, wound around electrical wire and passed through the stator, to be a communication path between sensors out side of the electric motor.

The invention will be described in more detail with reference to the Figures. Referring to Fig. 1 there is shown an electrical motor having a center rotor and a stator 2 which comprises a series of electrical wires 3 that are wound such that when an electrical current passes through the wires 3 a rotating electromagnetic field is created which induces the rotor to rotate relative to the stator 2. As shown in Fig. 2 and Fig. 3, at least one wire 3 has an electrical insulation coating 4 in which a fiber optical cable 5 is embedded, which cable 5 may be provided with suitable microsensors 6, such as an accelerometer to detect vibrations, and/or optic gratings, such as fiber bragg gratings 7 that reflect light of a wavelength equal to the grating width and allow light of other wavelengths to pass through the cable 7. The gratings 7 may be designed such that the reflected wavelength varies with temperature such that the fiber optical cable 5 forms an elongate string of miniature thermometers along the length of the wire 3. Likewise the optic sensors 6 may be formed by

seismic sensors which are formed by similar gratings that reflect varying wavelengths in response to vibrations so that the fiber optical cable 5 is an elongate multi-parameter sensor system that accurately detects any overheating and/or vibrations, for example when the associated pump is blocked or runs dry or when a bearing has worn out.

While this invention has been described in detail for the purposes of illustration, it is not to be construed as limited thereby but is intended to cover all changes and modifications within the spirit and scope thereof.

I claim:

1. A process for measuring and monitoring motor systems, said process comprising:

providing a motor system having at least one component selected from a stator and an armature, said at least one component connected to at least one electrical wire;

incorporating at least one means for data measurement with said at least one electrical wire;

collecting data with said at least one means for data measurement; and

transferring said collected data to a data collection station.

2. A process according to claim 1 wherein said means for measuring data is wrapped around said electrical wire.

3. A process according to claim 2 wherein said means for measuring data is encapsulated and attached to said electrical wire by covering or coating the electrical wire and the means for measuring data with an insulation material.

4. A process according to claim 1 wherein said means for measuring data is selected from optic fibers, sensors, micomachines, and combinations thereof.

5. A process for measuring and monitoring motor systems, said process comprising:

providing a motor system having at least one motor component selected from a stator and an armature, said at least one component connected to at least one electrical wire;

providing at least one means for data measurement;

connecting said at least one means for data measurement with said at least one motor component;

collecting data with said at least one means for data measurement; and

transferring said collected data to a data collection station.

6. A process according to claim 5 wherein said means for measuring data is contained within a tube.

7. A process according to claim 6 wherein said motor component is a stator and said tube is wound in said stator with said electrical wire.

8. A process according to claim 1 wherein said means for measuring data is selected from optic fibers, sensors, micomachines, and combinations thereof.

9. A process for measuring and monitoring motor systems, said process comprising:

providing a motor system having at least one motor component selected from a stator and an armature, said at least one component connected to at least one electrical wire;

winding at least one optic fiber around said electrical wire;

collecting data with said optic fiber; and

communicating said collected data to at least one sensor located outside said motor.

METHOD TO MONITOR INTERNAL PARAMETERS OF ELECTRICAL MOTOR SYSTEMS

Abstract

There is provided a process for measuring and monitoring motor systems, comprising providing a motor system having at least one component selected from a stator and an armature, which at least one component is connected to at least one electrical wire incorporating at least one means for data measurement, collecting data with the means for data measurement, and transferring the collected data to a data collection station.

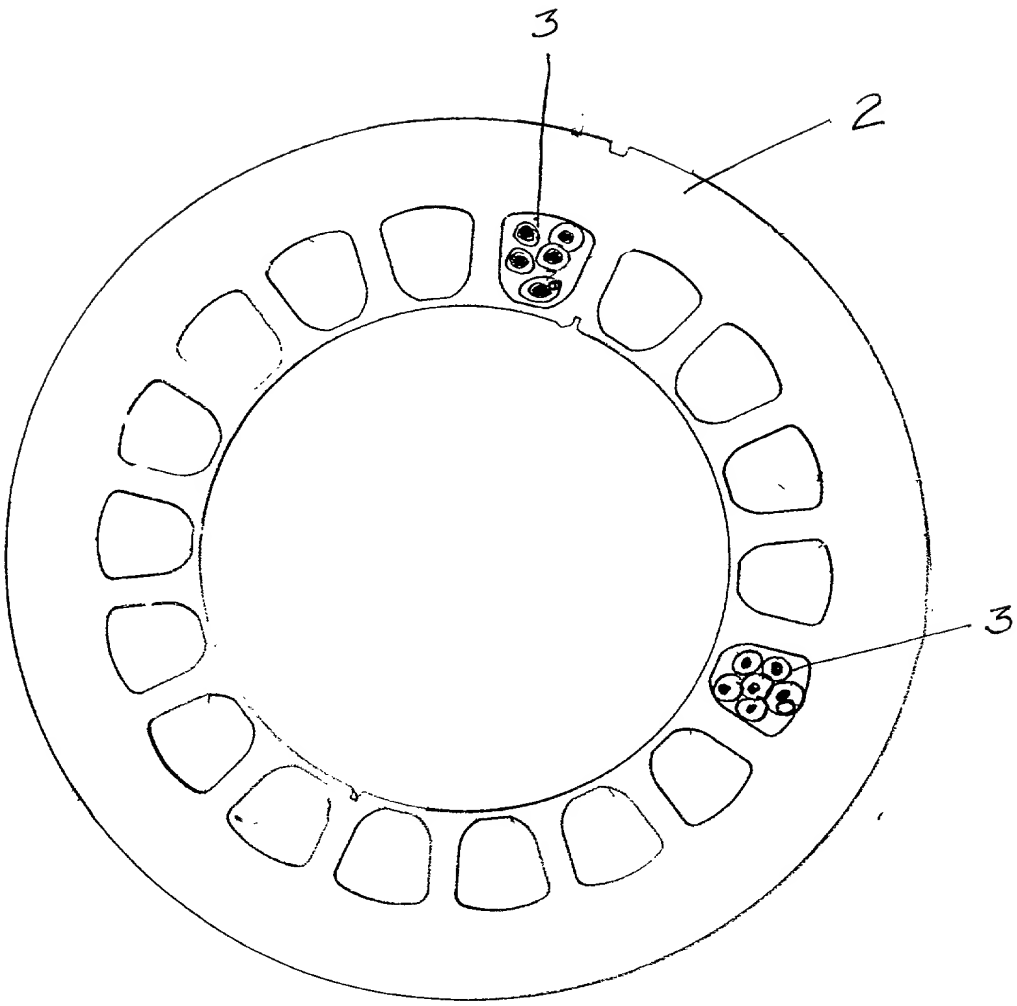

Fig. 1

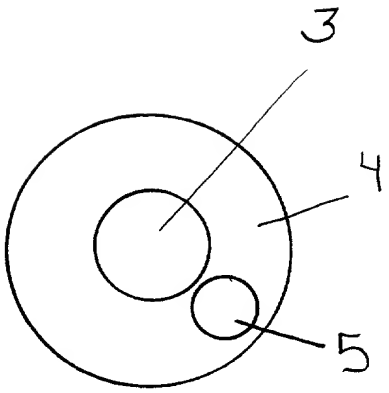

Fig. 2

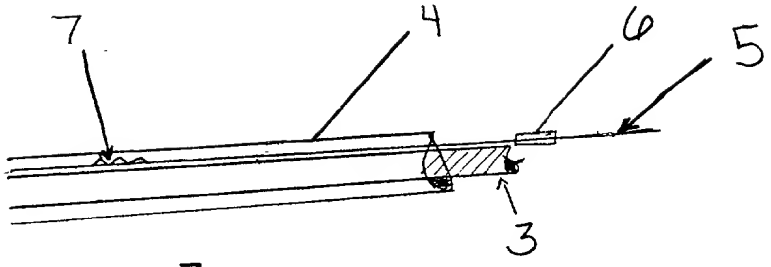

Fig. 3

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TH-1354 (US)
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DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled METHOD TO MONITOR INTERNAL PARAMETERS OF ELECTRICAL MOTOR SYSTEMS the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 27 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)

APPLICATION NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	Priority Not Claimed
			☐
APPLICATION NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	Priority Not Claimed
			☐

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

APPLICATION SERIAL NO.	FILING DATE
60/125,857	24 March 1999
APPLICATION SERIAL NO.	FILING DATE

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT International application designating the United States, listed below and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

APPLICATION SERIAL NO.	FILING DATE	STATUS-PATENTED, PENDING, ABANDONED
APPLICATION SERIAL NO.	FILING DATE	STATUS-PATENTED, PENDING, ABANDONED

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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Revised June 1995

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DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

ATTORNEY'S DOCKET NO.
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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David Randolph **SMITH**	
INVENTOR'S SIGNATURE	DATE SIGNED
RESIDENCE	CITIZENSHIP
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FULL NAME OF SECOND JOINT INVENTOR, IF ANY (given name, family name)	
SECOND INVENTOR'S SIGNATURE	DATE SIGNED
RESIDENCE	CITIZENSHIP
POST OFFICE ADDRESS	

FULL NAME OF THIRD JOINT INVENTOR, IF ANY (given name, family name)	
THIRD INVENTOR'S SIGNATURE	DATE SIGNED
RESIDENCE	CITIZENSHIP
POST OFFICE ADDRESS	

FULL NAME OF FOURTH JOINT INVENTOR, IF ANY (given name, family name)	
FOURTH INVENTOR'S SIGNATURE	DATE SIGNED
RESIDENCE	CITIZENSHIP
POST OFFICE ADDRESS	

FULL NAME OF FIFTH I JOINT INVENTOR, IF ANY (given name, family name)	
FIFTH INVENTOR'S SIGNATURE	DATE SIGNED
RESIDENCE	CITIZENSHIP
POST OFFICE ADDRESS	